Tilting of a 30-ton mains-frequency furnace at Guldsmedshytte Bruk, Sweden. The transport ladle has been lowered into a pit below floor level. (F 906)

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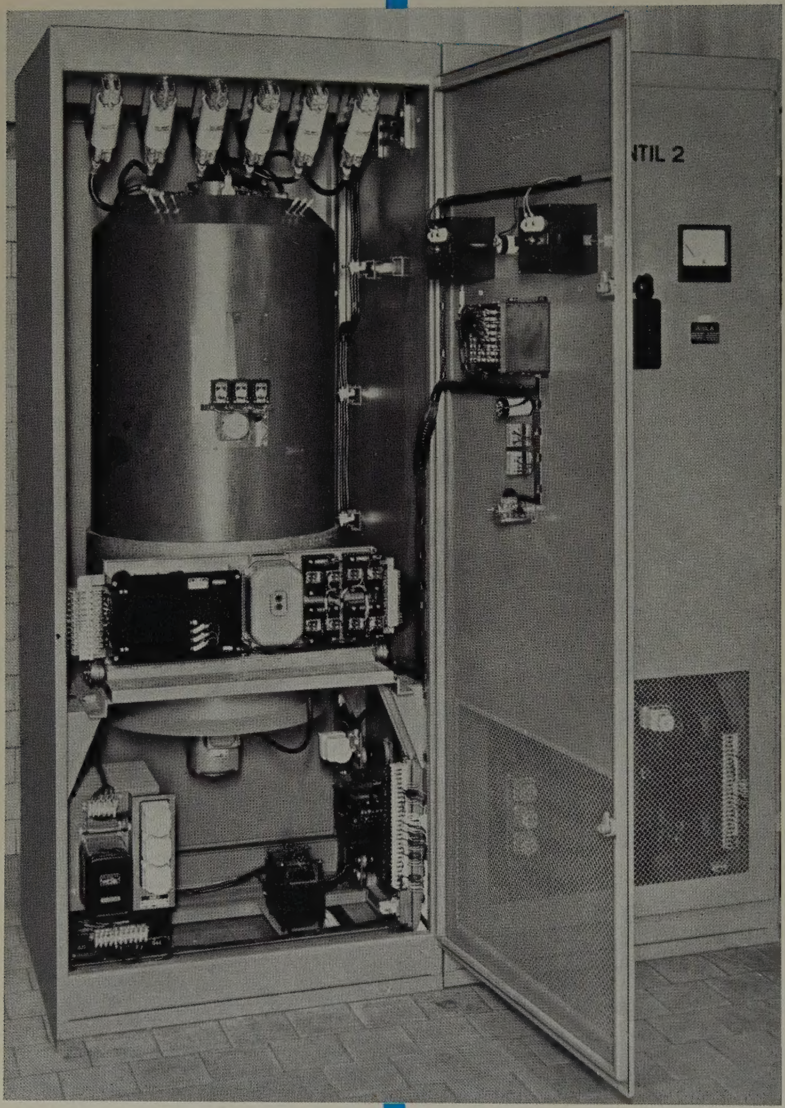
MERCURY-ARC RECTIFIER

type JSAK 5



(55038)

is a six-anode, air-cooled unit. It has grid control and can be used both as a rectifier and as an inverter.

The mercury-arc rectifier is of pumpless design and is built into a cubicle together with its auxiliary apparatus. This cubicle is 900 mm (35 in.) wide, 900 mm (35 in.) deep and 2,250 mm (89 in.) high, i.e., the same dimensions as for standard cubicles for control boards.

The auxiliary apparatus consists of the excitation and ignition equipment, anode fuses, fan with thermostat control and starter for the fan motor, as well as a control panel incorporating a relay station with relays for starting, stopping, supervision, etc.

Static converters with mercury-arc rectifiers of this type have been manufactured for the feeding of the field winding of large d.c. and a.c. machines, and have also been included in the auxiliary equipment for reversing rolling mills, etc.

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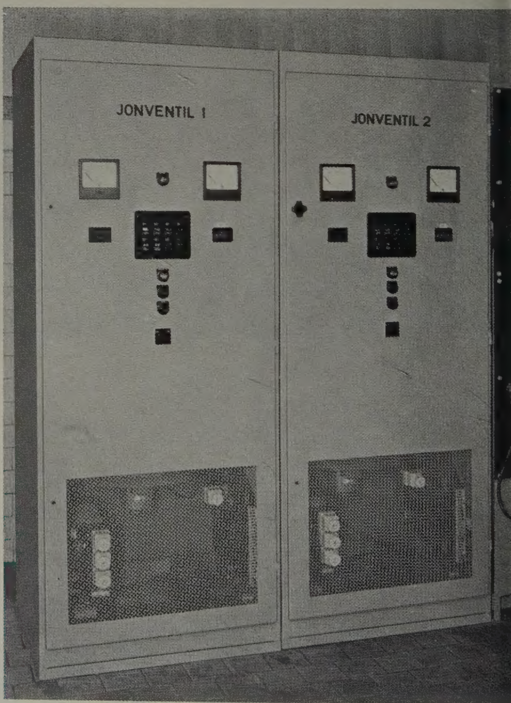

Type JSAK 5 can be supplied for direct vo
ages up to 900 V and for a continuous d
rating of up to 400 A.

ASEA

0-TON INDUCTION FURNACES FOR MELTING ND HOLDING IRON

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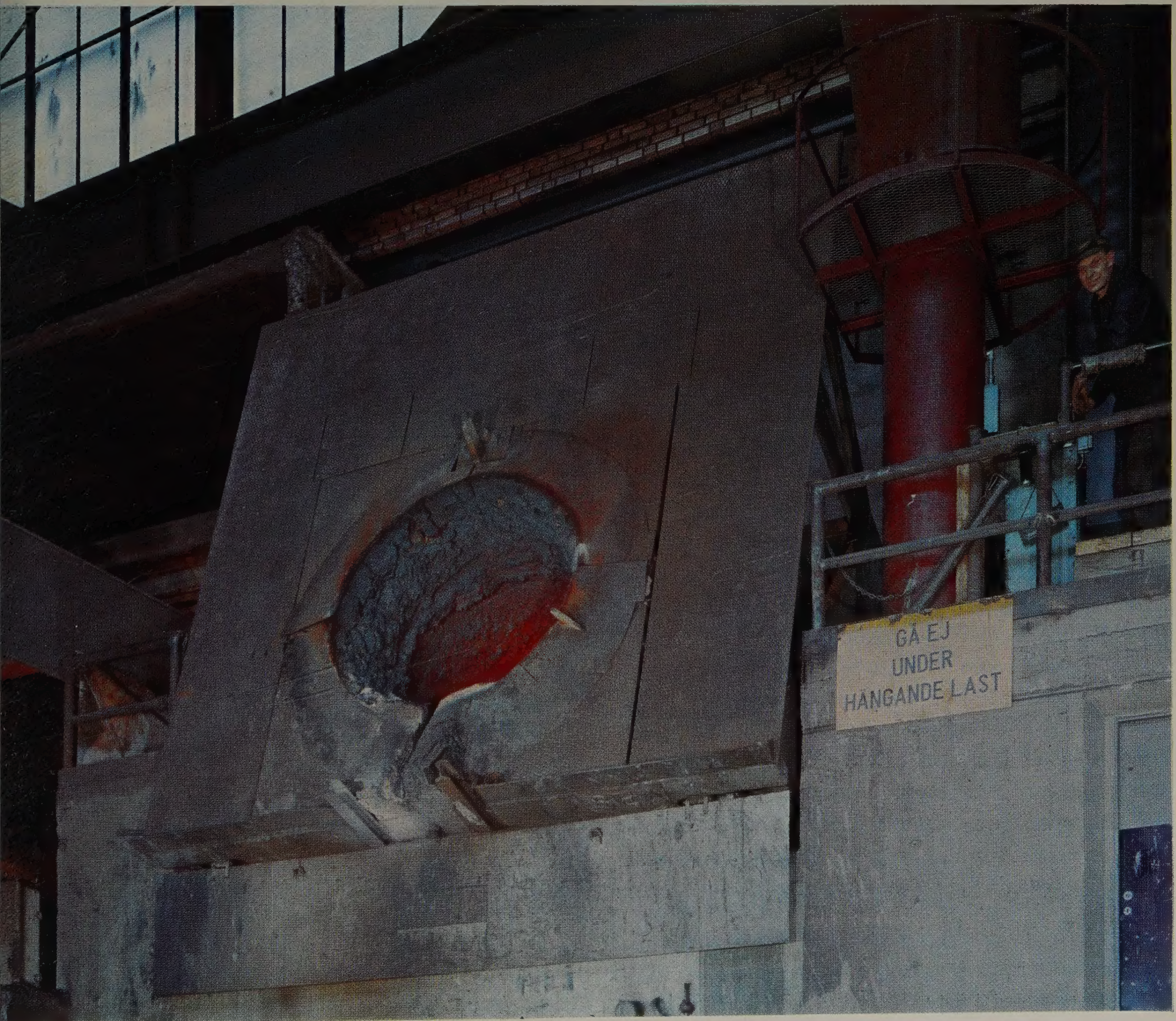
U.D.C. 621.365.5
Asea Reg. 664

e largest induction furnaces in Scandinavia, and obably in the world, for the electrical melting and lding of iron were installed and taken into service at 3 Åkers Styckebruk and at Guldsmedshytte Bruk in veden in the autumn of 1960. The furnaces are of sea type LFD, i.e., mains-frequency crucible furnaces 0 c/s), and have a charge capacity of 30 tons of olten iron.

AB Åkers Styckebruk, whose manufacturing programme includes rolls for calenders and rolling mills, had planned to make rolls of up to 60 tons raw weight in their present expansion programme. This created the problem of obtaining sufficient molten iron for casting such rolls. The melting normally takes place in high-frequency melting furnaces, but the total capacity of these by volume was not sufficient for casting the above-mentioned rolls. The idea then arose of obtaining a holding furnace in which it was possible to store a portion of the molten material from the high-frequency furnaces and thus accumulate the necessary raw weight for cast-



g. 1. Mains-frequency furnace for 30 tons at AB Åkers yckebruk in the tilted position. Height from floor to erating position 4.7 m (15 ft 5 in.). The crane column lifting the cover can be seen on the right. (F 945)

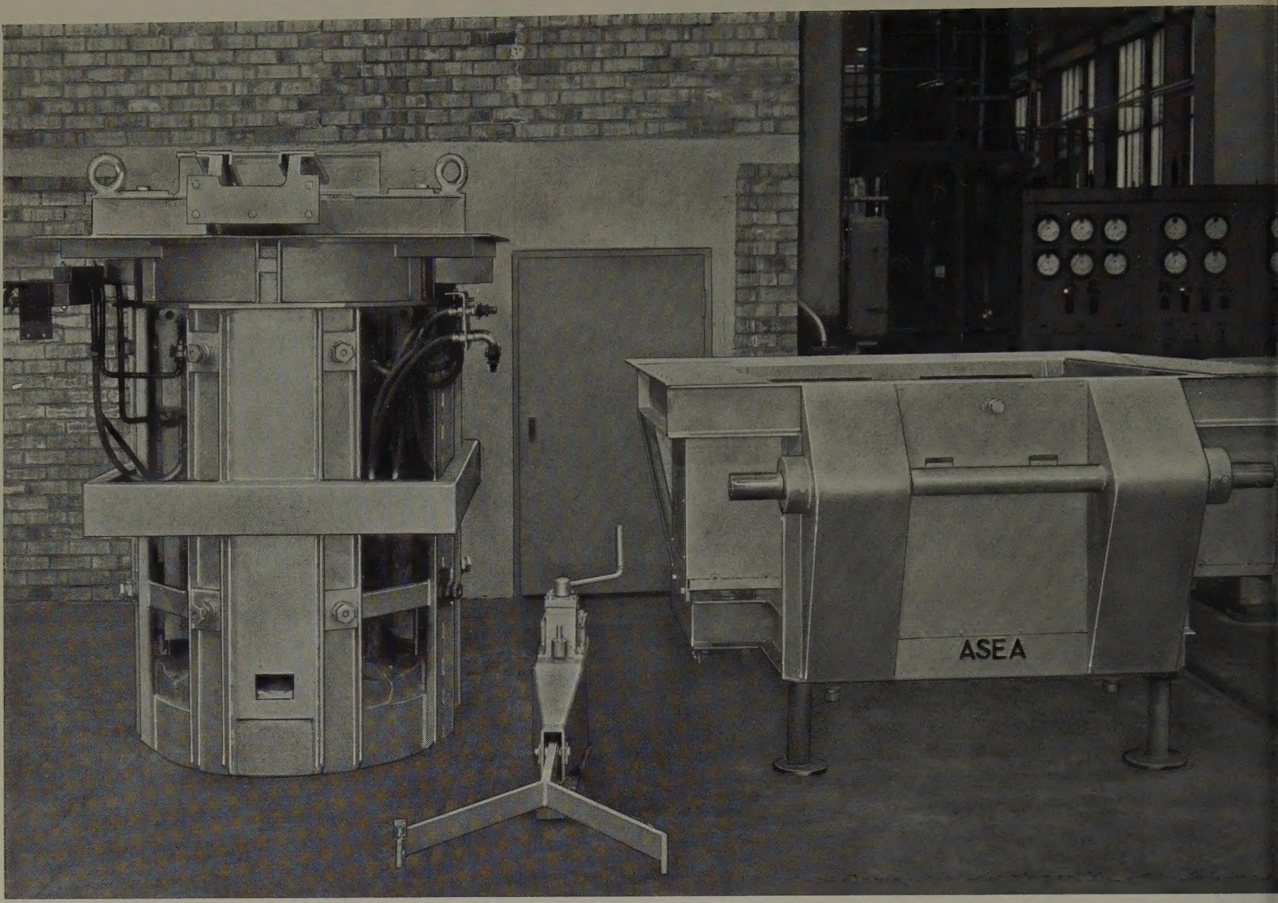


Fig. 2. Three-ton mains-frequency furnace dismantled for delivery. On the right, the framework with the pivoting axle for tilting. On the left, the furnace body with electrical and water connections for the coil and in the middle an arrangement for lifting the roof of the furnace. (54722)

ing. It was estimated that a furnace of 25 to 30 tons capacity would be suitable, as it would, in conjunction with the melting furnaces, enable about 60 tons of molten iron to be provided at any predetermined time.

The electrical equipment was so chosen that, in addition to holding, it would be possible to overheat the iron and even melt some cold material if required. Thus it is now also possible to use the furnace to melt iron for the manufacture of centrifugally cast pipes.

CRUCIBLES

The reason why furnaces of this size for iron have not been made earlier is primarily the problem of crucibles. The dimensions, i.e., diameter and depth, which determine the capacity of a crucible furnace, cause lining difficulties when they are increased to values exceeding the normal.

The following applies with regard to the diameter. For crucibles of normal type, which are rammed with dry
material (acid or basic), the surface of the crucible mu
be sintered in conjunction with the first melt. T
sintered surface, which is very thin during the first me
functions as a dome while the furnace is being tipp
and this must support the more or less powder-like u
sintered portion of the crucible lying behind. This co
dition limits the diameter of the crucible. If the crucil
diameter, and thereby the radius of the dome, is t
large, there is a risk that the sintered dome will cave

It can be pointed out that a wet-laid crucible, with cla
bound quartzite, does not give rise to similar proble
since the ceramic material sets and sticks to the roof
the arch formed by the massive copper coils. Howev
a crucible of this kind has disadvantages, such as
ferior heat resistance, and therefore shorter length
life. The highly desirable heat-insulating powder co
sistency in the vicinity of the coil is lacking. In additi
the drying time is inconveniently long. These disa
vantages of wet-laid crucibles make dry-rammed cru
bles preferable, at least where iron melts are concern

Nor can the depth of the crucible be made really lar
since the static pressure against the bottom of
crucible could be so great that problems would arise
conjunction with the strength of the crucible botto
The design of such furnaces calls for a careful balan
between the diameter and the depth of the crucil

Vhen determining the dimensions of the crucible, theoetical and practical considerations must be borne in ind concerning the electrical properties. Attention ust then be paid to the placing of the coil in reation to the melt, the movement of the bath, the fficiency, etc.

he determination of the crucible dimensions for the 0-ton furnace was preceded by a series of full-scale intering trials, which were carried out in collaboration ith Höganäs-Billesholms AB, who supplied the lining aterial for the first furnaces. A pre-fired graded uartzite was chosen as crucible material. Practical opertions have shown that the choice was correct.

ESIGN

he steelwork for a furnace for charges of the sizes in uestion must be very robust. The dimensions will, of ourse, be large, which can be seen from the picture n the cover, where a furnace at Guldsmedshytte Bruk shown, and from Fig. 1, which shows a furnace in the lted position at Åkers Styckebruk, where the furnace built into a platform.

order to keep the energy consumption during holding low as possible, it is important to limit the radiation om the surface of the bath. The furnaces are therefore rovided with well insulated roofs, which can be reained on top of the furnace opening even during the lting movement. Fig. 1 shows the tilting of a furnace ith the roof covering the crucible. For lifting the roof, d also for assistance during charging and repairs, a ushbutton-operated swivelling crane has been installed this plant. Fig. 6 shows a picture of the installation Guldsmedshytte Bruk, where the roof is operated by special roof-lifting device.

he furnace proper, usually called the furnace body, is ilt into a framework which can be tilted about the pping spout of the furnace. The furnace body consists a coil with transformer yokes built into a system of rders which can be lowered into the framework and cked in it. Fig. 2 shows the design of such an arrangeent for a 3-ton furnace. Fig. 3 shows a corresponding it for a 30-ton furnace.

ne of the great advantages with such an arrangement that, in the event of a fault in the crucible, the yokes coil, the whole furnace body can easily be replaced. he electrical and water connections between the furnace dy and the framework are easily accessible and reacement can therefore be carried out in a very short me.

nother advantage is that, for a normal crucible replaceent, it is possible to have a separate, already-rammed furnace body ready when the crucible in service is becoming worn out. It is thus possible to eliminate the ramming time in conjunction with a change of crucible. Only the sintering of the crucible need be carried out after the unit is placed in the framework.

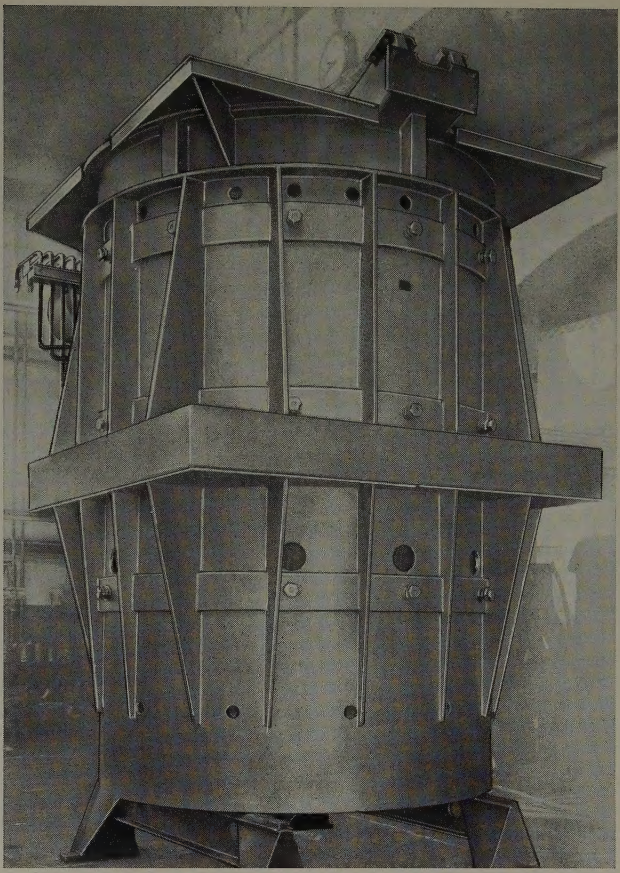


Fig. 3. Furnace body for 30 tons with connections at the rear. Height 4 m (13 ft), diameter 2.5 m (8 ft 2 in.) and weight 25 metric tons. (56470)

For weighing the charge, the furnaces can be placed in a framework resting on pressductors [see Asea Journal 32 (1959):9, pp. 115–123]. The output from the pressductor is transmitted to an indicating instrument mounted in the control equipment, see Fig. 6, where the instrument can be seen on the wall on the right-hand side. A great advantage with such weighing equipment is that it is possible at all times to check the quantity of melt taken from the furnace. At the commencement of a new charge it is also useful to know how much molten material (sump) remains in the furnace, especially if the new charge is to have a composition differing from the previous one. At such times the weighing equipment is invaluable.

A requirement in the case of plants for the holding of iron is that different quantities of iron should be stored without the efficiency becoming poor. Hence, the coil of the furnace must be formed in a special way. At

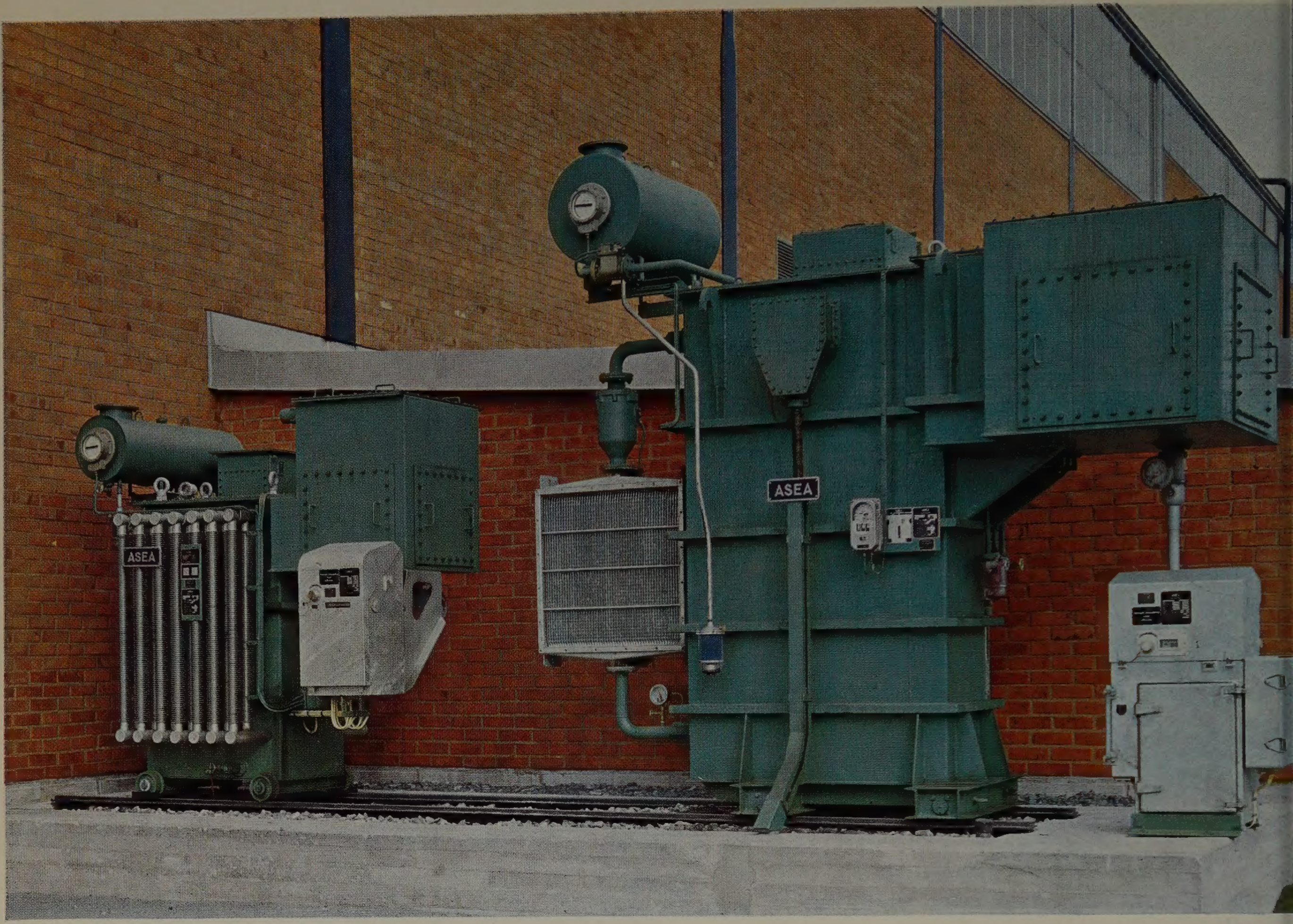


Fig. 4. Transformer (on the right) and reactor for furnace plant at Guldsmedshytte Bruk. The transformer is forced-oil-cooled and both transformer and reactor are provided with motor-operated tap changers. Transformer data: 2,100 kVA, 10,000/1,900–500 V, reconnectible on the secondary side in 10 steps in D-connection and 10 steps in Y-connection. Y/D-reconnection on the primary side. (F 902)

Åkers Styckebruk, the requirement was that a quantity as small as approximately 7 tons should be kept hot and hence, in this case, the coil was divided into three portions which can be switched in as required. The furnace at Guldsmedshytte Bruk has also been provided with a coil in three sections, but primarily in order to achieve greater flexibility of power supply to the different portions of the furnace so that it would be possible, amongst other things, to influence the stirring of the melt.

ELECTRICAL EQUIPMENT

The electrical equipment for a mains-frequency furnace plant chiefly comprises a three-phase regulating transformer which is reconnectible in several steps.

The furnace is single-phase-connected on the secondary side of the transformer. In order to achieve equal loading on the three phases a balancing arrangement is use consisting of a capacitor and a reactor, which are bot adjustable.

In general, the operation of the tap changers on th transformer and on the balancing reactor is carried ou by means of motor operating gear. This can then b pushbutton-operated from the control board in th vicinity of the furnace and it is possible to locate th transformer and reactor independently of the furnac Fig. 4 shows an example of such an arrangement ou doors which is sometimes advantageous from the vie of saving space.

A capacitor battery is connected in parallel with th furnace to cater for the reactive-power requirements the furnace. This consists of a "fixed" portion and adjustable portion. Regulation takes place automatical to suit the requirements of reactive power. The c pacitors are switched on and off by means of contacto Fig. 5 shows a parallel capacitor battery with some its contactors and the connections to these.

LAY-OUT

The plant can, of course, be built in different ways suit local site conditions. The furnaces can be built in platform, as shown in Fig. 1 (Åkers Styckebruk), or unk in the floor, as shown in Fig. 6 (Guldsmedshytte ruk). In the former case, the material must be lifted p to the platform for charging the furnace while cast-ng can be carried out without vertical lifting. In the tter case the furnace must be tapped into a ladle hich is sunk under the level of the floor and which ust therefore be lifted when casting (see cover illus-ation).

he parallel capacitor of the furnace should always be laced in the immediate vicinity of the furnace so that e busbars for the heavy current are as short as possi-le. The regulating transformer and load-balancing de-ices can, on the other hand, be placed farther away, s already exemplified in Fig. 4.

system of copper bars is placed above the parallel apacitor battery. These are fastened in special bus-ar holders which have recently been developed. The olders are built up of standard rolled-steel channels in hich busbar supports cast in polyester material are astened. The busbar supports are designed so that they an be combined to form a busbar holder for an arbi-ary number of bars and also for any arbitrary width f busbar. With the aid of this new type of busbar pport, it is possible to build up a busbar system of ny design easily and rapidly. The secondary connections om the regulating transformer and load-balancing de-ices are also placed in busbar system. The busbars run om the capacitor battery to selector switches for witching the furnace or furnaces in or out of circuit.

PPLICATION AND EXPERIENCE

common arrangement for induction melting furnaces that more than one furnace is installed for alternate onnection to the same electrical power and control lant. This saves time in service since it is possible to over to a ready-lined furnace when it is necessary change the crucible. Further, a high degree of relia-ility against possible faults is obtained since it is possi-le readily to change over from one furnace to the ther. Finally, it is possible, by using one furnace for olding while simultaneously melting in the other, to ccumulate a quantity of iron corresponding to the pacity of two furnaces.

he arrangement described above, with one furnace, ut two furnace bodies, partially satisfies the first two quirements, i.e., of time saving and reliability against terruptions in the event of faults, but the last-mention-l, and often occurring, requirement of accumulating rger quantities of iron is not satisfied.

kers Styckebruk is an example of a plant where it is ecessary to accumulate iron in large quantities. In 1962, another 30-ton furnace will be installed there. Hence the electrical equipment has been designed to enable connection to either the one or the other of the furnaces. After this expansion, it will be possible to increase the raw weight of rolls to approximately 90 tons.

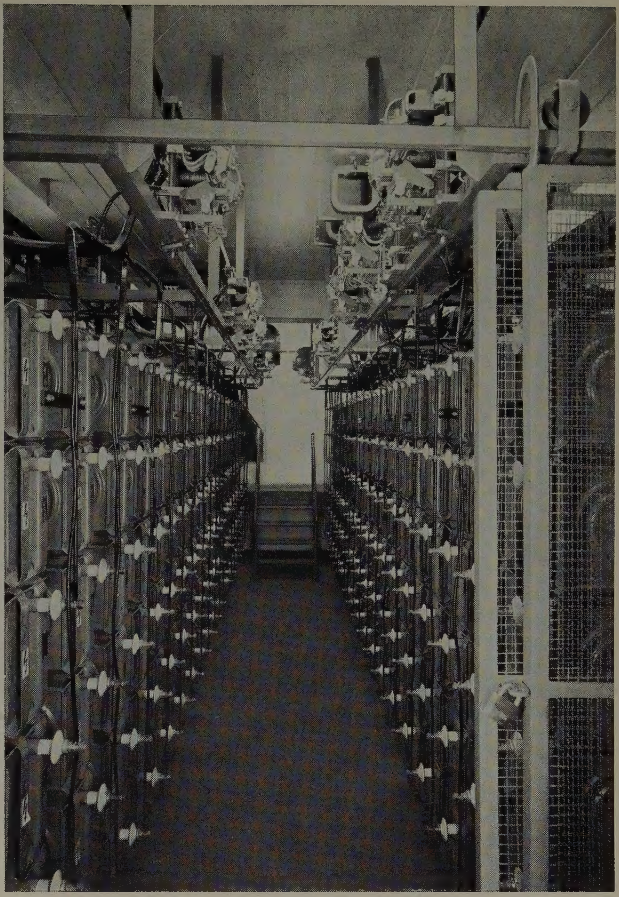


Fig. 5. Capacitor battery at Åkers Styckebruk for 12,000 kVAr, 1,450 V, built up of units of type CTD 2, 27 kVAr, 725 V each. Contactors for switching the battery groups can be seen above the capacitor groups. (56990)

The results from the two plants described above have been very good during the time they have been in service.

At AB Åkers Styckebruk, it has not yet been necessary to change the crucible after seven months of continuous operation. About 7,000 tons of iron have passed through the furnace. The temperature of the melt is 1,450°C.

In addition to the fact that the plans for the holding of iron for large rolls have been realised, the furnace has been of great use for the holding and melting of iron for the manufacture of centrifugally cast drain pipes, which are one of the chief products of AB Åkers Styckebruk. Temperature is of importance in the manufacture of these. The system used earlier with holding furnaces without power made it necessary to overheat the iron in the melting furnaces to compensate for the

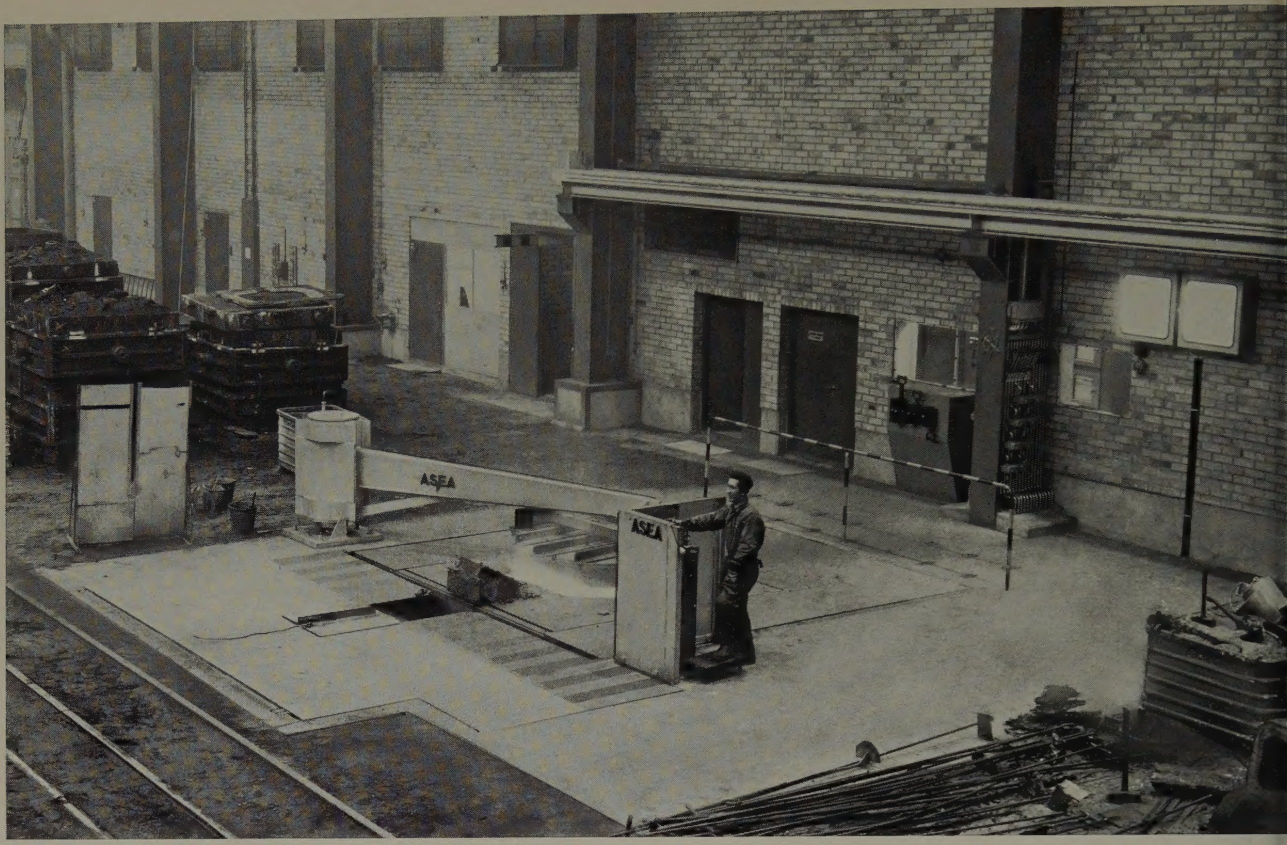


Fig. 6. 30-ton mains-frequency furnace at Guldsmedshytte Bruk in the normal position for melting. The figure shows the cover with its operating gear. On the right is the operating gear for regulation of the tilting speed. In the background on the right are the two instruments for weighing and temperature measurement. (56910)

temperature losses. As the temperature can now be kept constant in the new furnace, it is no longer necessary to overheat the iron. It has been shown that the rejects during the manufacture of pipes have become appreciably less than before.

In June, 1961, the furnace at Guldsmedshytte Bruk had been in service for about five months without re-lining. About 6,500 tons of iron had then passed through the furnace. At night, the furnace is used as a melting furnace and often melting commences with a cold furnace unit. During the day molten iron is brought from the blast furnaces. The iron is adjusted in composition, chiefly as regards carbon and silicon. This can be done rapidly and with a high yield owing to the reconnectible coils. The iron produced is used for the casting of chills of up to 22 tons weight for steelworks.

The experience gained has shown that crucible furnaces for iron even larger than 30 tons can be manufactured and lined with dry lining. It can be mentioned that furnaces of 50 tons charge capacity are now being designed by Asea.

CONCLUSION

Finally, some comments will be made on the advantage and disadvantages of large induction furnaces of th crucible type as active mixers for cast iron in foundrie in general. The need for an active mixer, i.e., a mixe with a possibility of supplying additional energy, i foundries has been ever increasing. We shall not discuss this increased need here, nor shall we discuss wh the supply of energy by electrical means has such grea advantages, but we shall limit our comments to genera remarks on the choice between the two electrical alternatives on the Asea manufacturing programme, namel the choice between induction furnaces of crucible typ and induction furnaces of channel type.

Side by side with the development of the large inductio furnace of crucible type described above, Asea hav worked on the development of large induction furnac of channel type for holding iron. Channel furnaces, a holding and melting furnaces, are already well know especially in the non-ferrous field. Asea have utilise the experiences from this field for designing a holdin furnace for iron designed so that it is easy to repla the channel units or inductor units, as they are al called, without its being necessary to empty the furnace The limited length of life of these channel units w then no longer be a decisive factor. Such a holdin furnace for 14 tons of iron has now been in service f approximately a year at the Asea foundry in Väster

see Asea Journal 34(1961):10, p. 183] with very good
esults. These results will be described later in a separate
rticle.

Iowever, it should be pointed out here that a furnace
f channel type can be made with very good heat insu-
ation for the iron container. Only in the channel itself
; it necessary to reduce the thickness of the ceramic
ısulation to obtain good electrical efficiency for the
upply of energy to the melt. This results in a difference
ı principle between the channel furnace and the cruci-
le furnace as in the latter the supply of energy takes
lace mainly on the outer sides of the melt and, in that
vay, there is a comparatively thin ceramic surface be-
ween the hot melt and the water-cooled furnace coils.
n spite of this deviation from good heat insulation it
ıas proved that induction furnaces of crucible type do
ıot give rise to heat losses which are of consequence.
'he 30-ton furnaces described above require a power
upply of 250 kW for holding in a new crucible and
00 kW for a worn crucible. In both cases, the furnaces
re provided with heat-insulating roofs.

ι holding furnace of crucible type is more expensive
ı purchasing costs than a similar one of channel type.
'he chief reasons for this are that, for a crucible furnace,
large capacitor battery for power-factor correction and
evices for three-phase load symmetry, as described
bove, are necessary. A large portion of the price differ-
nce lies in the fact that it is economical to utilise some
f the latent possibilities of a crucible furnace since the
urnace can easily be adapted for melting cold material.
'herefore, larger power margins are often built into the
lant and the furnace is designed and built in the
oundry so that it is possible to charge it efficiently with
old material.

The advantages of the crucible furnace as compared with channel-type furnaces can be summarised as follows: The furnace is simple and extremely easily maintained in operation. Its lining is cheap. Temperature control is excellent. It has great flexibility since it can, to a large extent, be used for melting cold material. It can be completely emptied. The furnace can be started very rapidly, for example, when it has to be taken into service after re-lining, and it is possible to adjust the composition on the basis of the excellent stirring effect.

On the other hand, the advantages of the channel-type furnace are that the initial capital outlay is less, the building foundations for it can be rather simple, it has greater flexibility with regard to location and its heat losses are relatively small.

When it is a question of deciding which of these two types of furnace to use in a foundry for accumulation purposes, the local conditions should be carefully surveyed to decide which furnace is the more suitable. In general, a crucible-type furnace can be recommended when it is necessary to accumulate and hold iron for relatively brief periods at a certain temperature or even to raise its temperature. A typical field of use is where the weight of castings is greater than that obtainable from melting furnaces proper at any one time. If, in addition, it is essential that the furnace should receive cold material for melting, then there are good reasons for the selection of a crucible furnace.

In the case of buffer accumulation of molten iron from melting units so that the latter can be operated continuously independently of the time of casting, and if there is no need to melt cold material, the selection of a channel type of mixer would be more justified.

THE MANUFACTURE OF CONTROL RODS IN THE ASEA NUCLEAR POWER DEPARTMENT

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U.D.C. 621.039.562.24.002
Asea Reg. 3855

The article describes the method by which control rods have been manufactured for the Ågesta reactor in Sweden and the Halden reactor in Norway.

A control rod performs its function in a nuclear reactor by absorbing the excess of neutrons which participate in the fuel reaction. Several elements are known to possess this neutron-absorbing capacity, but few hav been developed to such a stage that they can be manufactured into control rods. This article describes hov control rods have been manufactured for the Ågest pressurised-water reactor in Sweden and the Halde boiling-water reactor in Norway. The development an manufacture of both sets of control rods has been carrie out in close co-operation with the respective customers AB Atomenergi, Stockholm and Institutet for Atom energi, Kjeller.

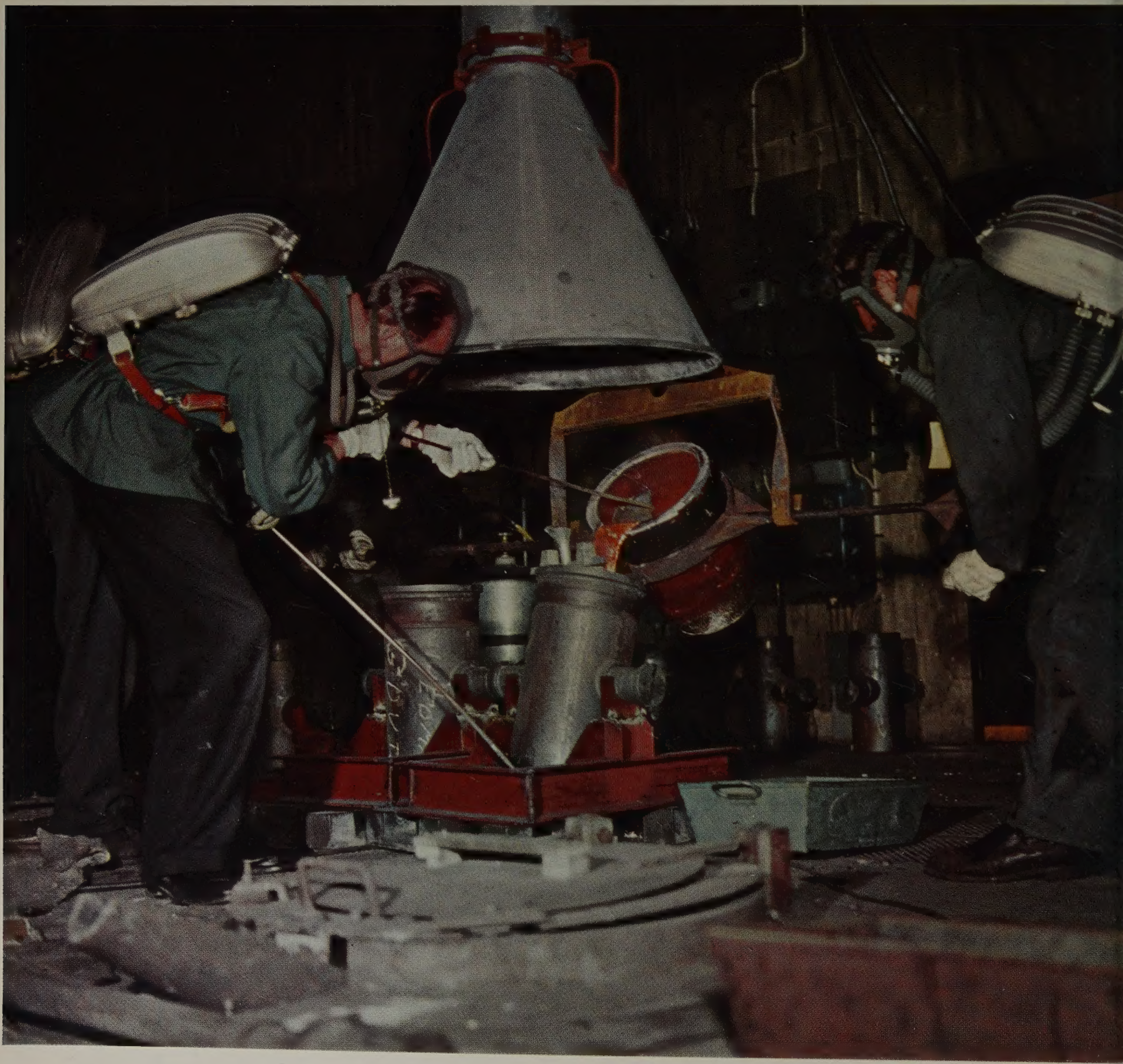


Fig. 1. The casting of a silver-indium-cadmium extrusion billet. (F 678)

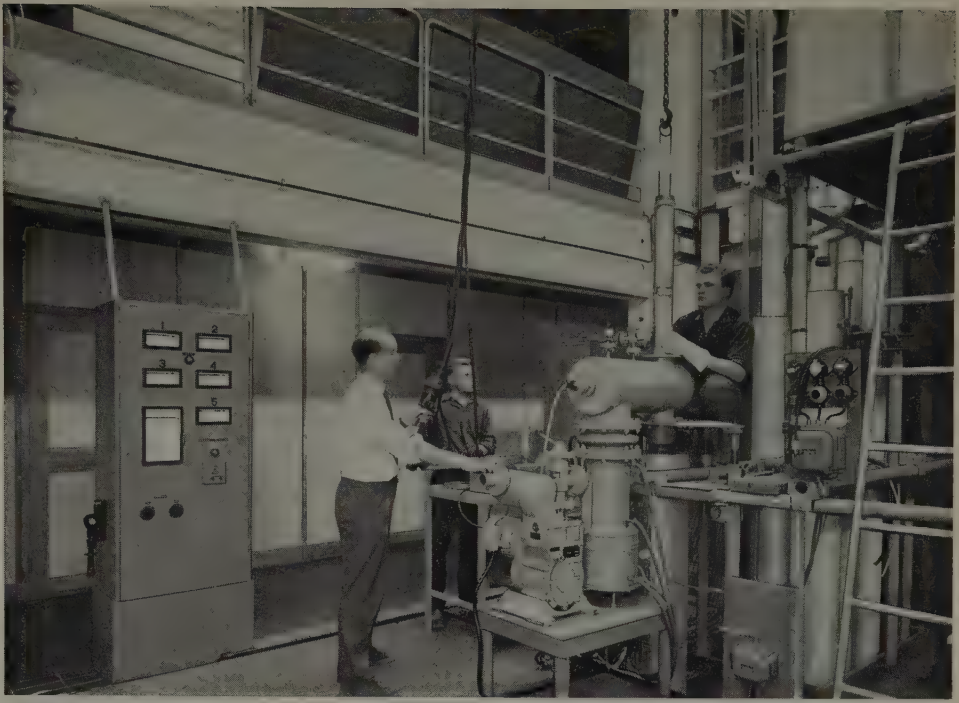


Fig. 2. Removing an Ågesta ompound tube from the vacuum furnace after dif-usion annealing. (Z 12393)

For physical and metallurgical reasons an alloy of silver ogether with 15 % indium and 5 % cadmium was elected for the Ågesta reactor and an alloy of silver with 30 % cadmium for the Halden reactor. Neither of hese alloys, however, meets the stringent requirements of mechanical strength at the operating temperature of he reactor or of resistance to corrosive attack. Because of these deficiencies it was decided to clad the neutron-absorbing silver alloys with stainless steel.

The dimensions of the rods that are being manufactured are given in Table 1. Both sets of control rods are of ubular form.

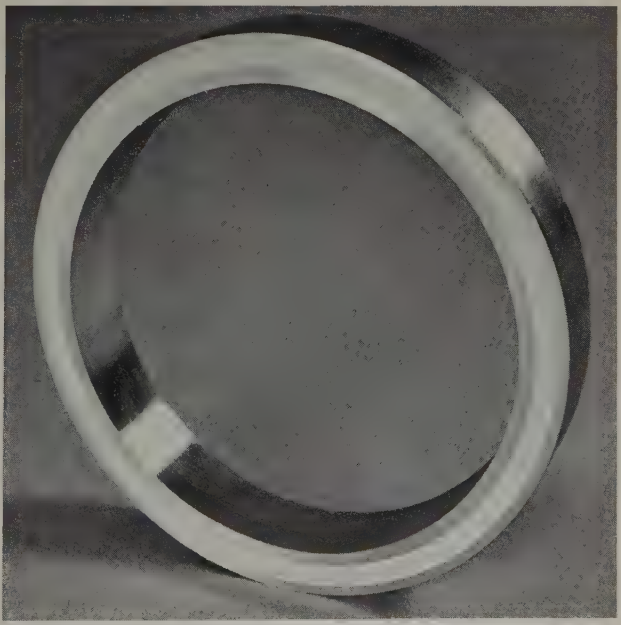
Table 1. The dimensions, in millimetres, of the control rods at present being manufactured by Asea.

Reactor	Outer diameter	Outer cladding	Absorber	Inner cladding	Length
Ågesta	104	2.0	3.5	3.0	4,000
Halden	70	1.0	1.5	1.0	2,000
Halden	53	1.0	1.5	1.0	2,000

MELTING AND CASTING OF SILVER-INDIUM-CADIUM ALLOY FOR ÅGESTA

A silver-30 % cadmium master alloy was made up in 10 kg charges by melting down the silver in a high-requency furnace using a graphite crucible and a charcoal flux. When the silver had been sufficiently uperheated, the cadmium, in stick form, was added and tirred in with an iron rod. The charge was poured into graphite-washed iron moulds without reheating. The silver-cadmium master alloy was remelted with indium and silver to produce the silver-indium-cadmium alloy. This virgin ingot or remelted scrap was remelted after analysis and sufficiently superheated for casting into billet form. Gun-barrel type moulds were used and the billets were top-poured. Adequate feeding of the billets was ensured by using an exothermic feeding-head sleeve and covering the feeding head with exothermic powder. More elaborate methods of casting were found to be unnecessary since the surface obtained by this method did not influence the quality of the extrusion. Special precautions were taken during all melting and casting

Fig. 3. Section of a composite tube. (Z 11960)



operations against the possible inhalation of toxi cadmium fumes which are evolved during these operations (see Fig. 1).

After a homogenising treatment in an air-circulatin furnace, the billets were pierced and extruded at Svensk Metallverken on a 2,000-ton press using a floatin mandrel technique. The extruded tubes were cold-draw to the required dimension in five passes without a intermediate anneal.

SURFACE TREATMENT OF CLADDING TUBES

One essential difference between the Ågesta control rod and those for the Halden reactor is that the cladding o the Ågesta rods is metallurgically bonded to the neutron-absorbing silver alloy. As a preliminary stage to bonding those surfaces of the stainless-steel cladding tubes whic were to come into contact with the silver alloy were activated and then consecutively nickel, and copper, plated The steel tubes for the Halden control rods wer thoroughly cleaned by degreasing and pickling befor compound drawing.

COMPOUND DRAWING AND ANNEALING

After assembly, the cladding tubes and the silver tube were co-drawn at Sandviken Steel Works using standard plug and die technique. The dimensions of th tubes were so adjusted as to give a reduction of approximately 10 % in wall thickness in each of the thre component members of the compound tubes. This metho of drawing produced intimate contact between th surfaces which was maintained during the stress-relievin of the Halden rods and diffusion annealing of the Ågest tubes. The heat treatments were carried out in vacuu and in the case of the Ågesta rods diffusion occurre between the electroplated copper layer and the silve alloy with the formation of an intermetallic compound An ultrasonic inspection procedure was developed t examine the quality of the bond.

WELDING AND FINAL SURFACE TREATMENT

The silver alloy was machined out at each end of th composite tube to a depth of 10–15 mm (0.4–0.6 in. and filler rings were welded into each end using automatic tungsten-argon arc-welding equipment. The seale compound tubes were electropolished to a surface finis of better than 3 μ.

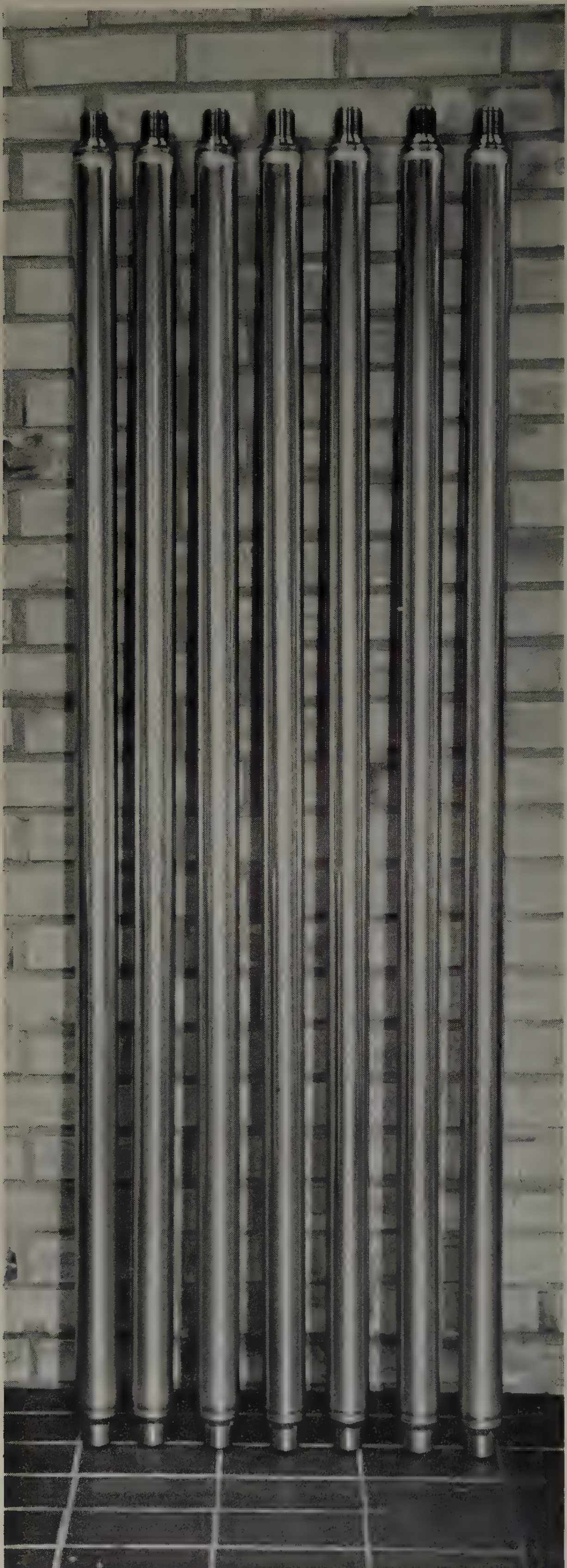


Fig. 4. Some of the finished Halden control rods. (Z 12897

OVERHEAD CRANES FOR AN IRON STORE

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Asea Reg. 6342

The article describes a type of crane in which the crane bridge consists of a main trapezoid section and the crab of which is provided with a driver's cabin mounted on a trolley. Five cranes of this type have been supplied o Domnarfvet Steelworks in Central Sweden. The de-ign of the crane is such that the maximum amount of tore space can be utilised.

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ig. 1. The box-type bridges for single-beam overhead cranes or a load of 10 tons being manufactured in the factory. pan 29 m (95 ft). (53406)

At the beginning of 1960, a new iron store was taken into use at Domnarfvets Jernverk in Central Sweden. Steel sheet and rods are stored in this building before being sent out to the customers. The iron store has a total area of about 24,000 m² (258,000 sq.ft) and is divided up into four bays. All handling of material in the store is done with the aid of five 10-ton overhead cranes, each of which is provided with a boom. The nature of the premises and the material, as well as the requirements made on the design and method of use of the overhead cranes were contributory factors in the selection of a type of crane of new and interesting design, see Fig. 2.

THE MAIN DATA

Each overhead crane is designed as a single-beam overhead crane with a crab running on top of the crane bridge, and with its hoisting ropes running down on each side of the bridge. The hoisting ropes carry a boom for lifting rods with the aid of chains. In the case of one of the cranes, the lifting boom has been provided with magnets for lifting sheet steel.

The overhead crane has the following main data:

Hoisting power at the boom	10 tons
Span	29 m (95 ft)
Hoisting height	7 m (23 ft)
Hoisting speed	0.25 m/s (10 in./s)
Crab travel	0.63 m/s (2 ft 1 in./s)
Crane travel	2.0 m/s (6 ft 7 in./s)

THE DESIGN OF THE CRANE BRIDGE

The crane bridge and end carriages are of box type and are welded together to form a stable unit. There is a gangway along the bridge on the travelling machinery side.

Since the crane bridge has been designed as a single beam, it has been possible to achieve a considerable saving in weight as compared with an overhead crane bridge of conventional design. The beam has a trapezoid cross-section. This made it possible to make the gauge of the crab relatively large, at the same time as an adequate base was obtained for the travel machinery (Fig. 1) which is located at the same level as the baseplate of the bridge.

The space inside the beam is so large that some of the electrical equipment has been placed inside it.

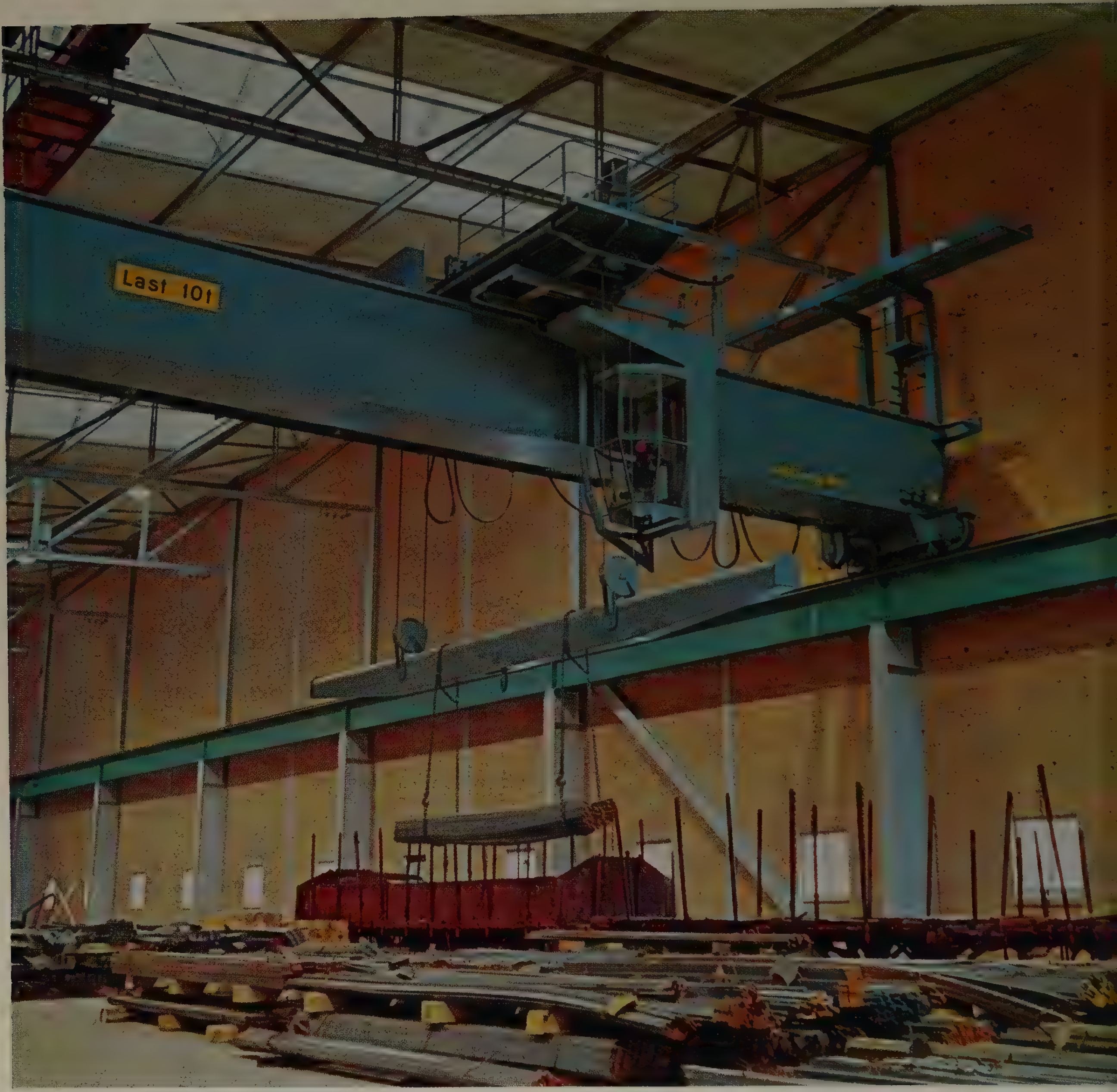


Fig. 2. A 10-ton single-beam overhead crane in the new iron store at Domnarfvets Jernverk. (F 712)

THE CRANE TRAVEL MACHINERY

The driving motor and gearing are located in the middle of the bridge. In addition, gearing is provided in conjunction with one of the wheels in each end carriage. All the gearing is of oil-lubricated type. The gear wheels are welded and have helical teeth. The gearbox is of entirely welded design and great care has been taken to see that the bearing bushings are oil-tight. The longitudinal driving shaft is connected to the gearing by means of SKF compressed-oil couplings of type OK.

The wheels have no flanges and are shrunk on to the axles. The treads of the wheels are of high-quality steel and have been shrunk on to the cast-iron centre
The wheel-base is relatively small, but the overhea
crane is guided by horizontally placed guide roller
fastened to relatively long carriage extensions (Fig. 4
The steering-base ratio, that is to say, the ratio betwee
the distance between the guide rollers and the span,
large. This means that the overhead crane runs alon
the track particularly well.

THE DESIGN OF THE CRAB

The framework of the crab consists mainly of sheet ste
which has been welded together to form box section
The gearing of the hoisting mechanism has been co
centrated in a centrally located oil-lubricated gearbo
All the gear wheels are welded and have helical teet

ig. 3. The driver's cabin is rovided with windows so rranged that the driver as a good view of all the remises. The cabin can be oved backwards and forards so that the crab can e run very close to the ar crane track. (F 713)

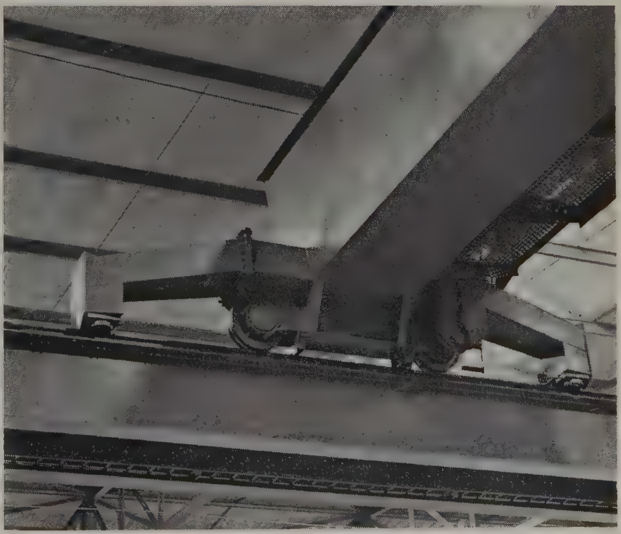
he boom is carried by two ropes. The one end of the ope in each line is wound up over a rope drum, the ther being fastened to a rope-fixing device so designed at the tension on the rope actuates a pressductor. By is means, the crane has been provided with an effective verload protective device and with a weighing device hich is so designed that the crane driver can read off n an instrument in the cabin the weight of the load n the boom.

he crab travel machinery is provided with a welded earbox containing all the gearing. Here too, the gear heels are entirely welded and are oil lubricated. The heels of the crab are, as was the case with those of e crane bridge, shrunk on to the axle and have a ring f forged high-quality steel shrunk on to a central cast-on core.

HE DRIVER'S CABIN

he drivers' cabin has been placed on the crab in order provide the best possible view of the store. Further,

Fig. 4. The end carriage with wheels and guide rolls on the 10-ton single-beam overhead crane. The steering-base ratio is large and therefore the crane runs very well along the track. (54526)



the cabin is mounted on a carriage which can be moved backwards and forwards under the crab. When the crab is run towards the rear crane track, the cabin is automatically moved in under the crab thus making the distance between the load boom and the wall very small. This makes it possible to use all the floor space.

In the other positions along the crane bridge, the cabin takes up its normal position, which means that the driver is very favourably placed to obtain a view of the load when he is over the greater part of the storage space.

The driver's cabin is completely enclosed, but is provided with windows so arranged that the driver has an extremely satisfactory view over the entire premises (Fig. 3). The cabin and control devices are of the latest Asea design as described in Asea Journal 34(1961):7, pp. 123–126.

ELECTRICAL EQUIPMENT

Asea heavy-duty induction motors of type MARE hav been installed in these cranes. Cam controllers of typ CKME (see Asea Pamphlet No. 7717 E) are being use here for the first time in an actual installation.

The contactors are of type ELB, which means that th operating coils are fed with direct current from an operating-current rectifier (see Asea Pamphlet No. 7460 Ea)

The controller resistors have vibration-proof elements The main current is supplied to the crab by means o a three-pole shielded contact rail of Asea type LLKA and the operating current by means of rubber-insulate cables.

One of the cranes has been provided with a rotary converter from which direct current is supplied to the lifting magnets.

AN AMPERE-HOUR METER FOR SUBMARINES

Lennart Faxö, High-voltage Laboratory, Ludvika

U.D.C 621.317.787.
Asea Reg. 0973

A special electronic ampere-hour meter for checking the rate of discharge of submarine batteries has been designed which accurately registers current consumption down to one thousandth of the full-load current.

Checking the condition of a submarine battery by measuring the quantity of electric charge taken out is complicated by the fact that the load can vary from a few amperes during periods of inactivity to thousands of amperes when proceeding under water. Furthermore, the efficiency of the battery, which is a complicated function of the discharge current, discharge time and recovery time, must be taken into account.

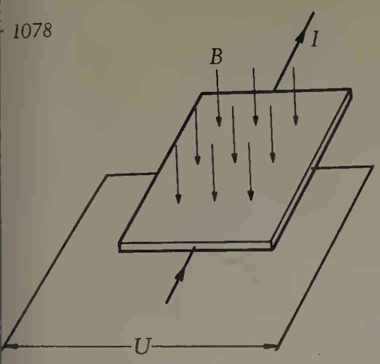
Up to the present time, ampere-hour meters have had a starting current of a few per cent of the full-load current. If the latter is assumed to be 5,000 A, the meter will consequently not register at currents below approximately 100 A. A 10,000 Ah battery could therefore be completely discharged within four days without the slightest discharge being registered by the meter.

In view of this, the lower limit of the current measuring range has to be extended considerably to include a thousandth or less of the rated current. As is usual with integrating meters, the measuring error must be referred to the actual current value, a circumstance which in this particular case leads to especially severe demands on stability and freedom from disturbance. If a measuring error of max. 2 per cent is assumed and a 60 mV shunt is used, the maximum permissible voltage error will be only 1.2 μV. On the other hand, a larger shunt coul scarcely be used, since even the 60 mV shunt, at 5,000 A has a power loss of 300 W.

These difficulties have led to the design of a specia ampere-hour measuring device for submarine batteries The current is measured with the aid of a Hall generato [cf. Fig. 1 and Asea Journal 34(1961):1–2, pp. 9–12] placed in the air-gap of an iron core, which surround the current conductor (Fig. 2). As is known, the Hal generator produces a voltage which is proportional t the flux density, if the control current is kept constant Through careful selection of the core material and th load resistance, it has proved possible to achieve proportionality between direct current and output voltag throughout the whole requisite current measuring range The method implies a considerably higher output voltag than that obtained from a shunt with reasonable powe losses.

The ampere-hour meter (Fig. 3) consists of a highl sensitive measuring motor driven by a direct-voltag amplifier. The motor is equipped with a pointer and scale. On the input side of the amplifier the Hall voltag is compared to a negative feed-back voltage, proportiona to the electromotive force of the motor and thus to it speed. This voltage is taken out across a bridge in whic the motor is connected up in such a way that the resistance-voltage drop is eliminated. A powerful eddy current damping of the motor and internal feed-back i the amplifier also contribute to the linearisation an

- 1078



B Magnetic field
I Control current
U Hall voltage

g. 1. *Hall generator.*

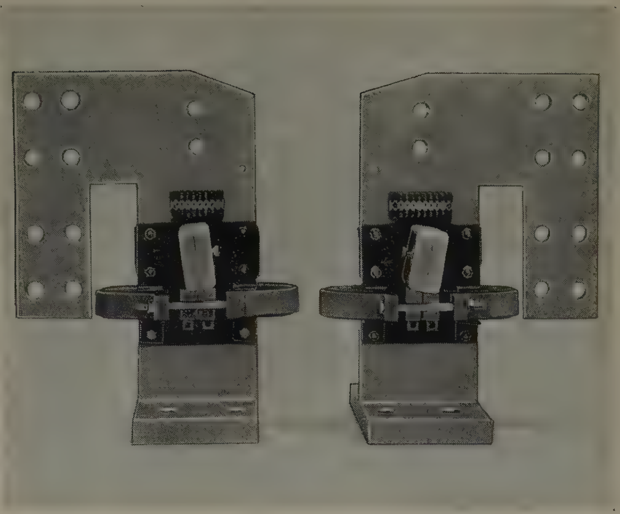


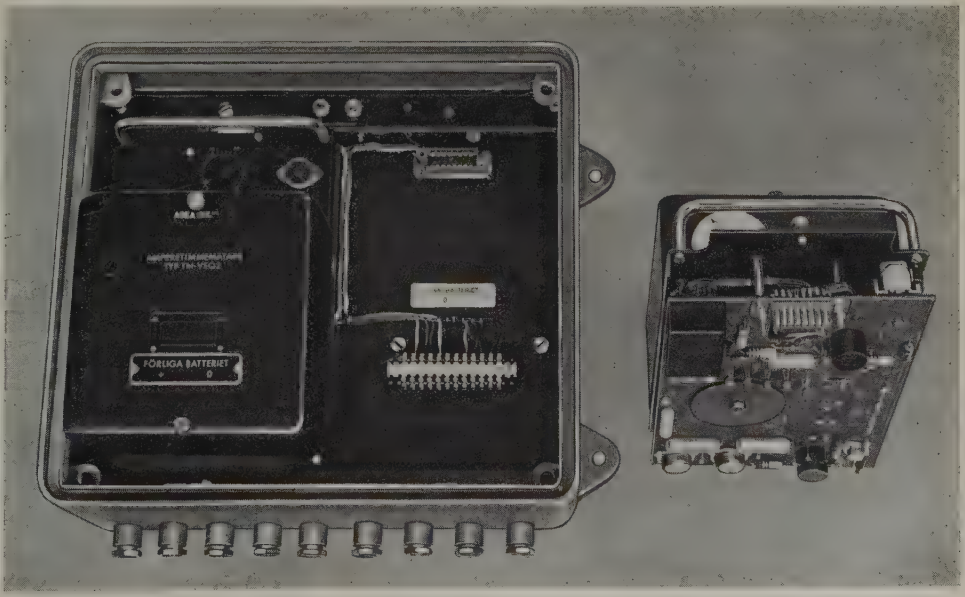
Fig. 2. Connection pieces fitted with current-measuring devices. The polarised switching relays are placed at such an angle that the influence of the external fields will be as small as possible. (55251)

abilisation of the meter. The amplifier is in the form of modulator amplifier, i.e., the direct-voltage signal is iopped to give alternating voltage, and then amplified id phase-rectified by the chopping voltage.

/hen charging, the efficiency of the battery is ifeguarded by reducing the control current of the Hall enerator. A relay is used for switching. The extensive irrent measuring range here presents yet another oblem, since it has proved difficult to combine the quisite sensitivity with resistance to overloading (up 10,000 times the operating power). This problem has een solved by replacing the relay coil by an external agnetic circuit which encloses the current conductor id is so designed that it protects the relay from overads by saturating it.

ll auxiliary power is supplied from the battery itself. hus measuring errors resulting from the failure of exrnal voltages are prevented. Since several galvanically parated direct voltages are required, the direct feed oltage is first chopped to give an alternating voltage ith a rectangular form, and is then transformed and ctified. The alternating voltage is also used for controlling the modulator and demodulator circuits of the amplifier. All feed voltages are stabilised against variations in the battery voltage, which can be as much as ±40 per cent.

The auxiliary circuits and amplifier are built up from transistors and Zener diodes. The latter, the reverse voltage of which is limited to a fixed value by the Zener effect, are used for stabilisation and voltage reference. The mechanical construction is compact; space requirements are about the same as for a conventional meter. The plug-in design makes it easy to replace. When charging, the required reduction factor may be most conveniently set by means of a knob (which can be locked), and is read off on a scale marked "Efficiency %".



g. 3. Casing for two am-re-hour meters. The harging efficiency" can set using the knob sible at the upper end of e left-hand meter. The eter on the right has been ken out of its casing; on the base board and the npere-hour scale (partly scured) can be observed. 5252)

SUPPLY-VOLTAGE STABILISERS AND REGULATORS

Bo Nylund, Static Converter Department, Ludvika

U.D.C. 621.316.722.
Asea Reg. 4795, 572

Brief description of the standard series of Asea supply-voltage stabilisers for 100–1,000 VA and supply-voltage regulators for 1–44 kVA.

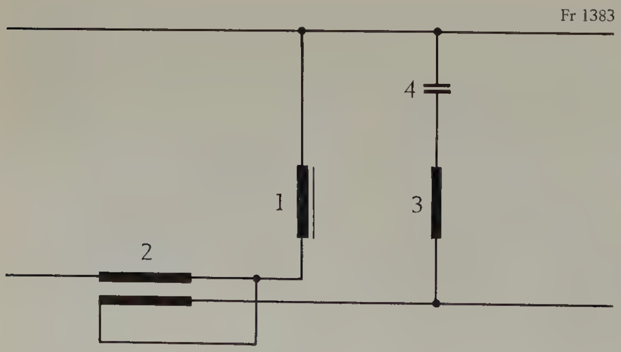
The voltage variations occurring in low-voltage networks are often so pronounced that they have a deleterious effect on the operation or life of apparatus connected up to the network. These drawbacks can be eliminated, however, with the aid of supply-voltage stabilisers and regulators. When connected up between the network and the consuming apparatus, such a regulator yields a constant voltage, even if the incoming voltage varies within wide limits. As a result, the apparatus operates more reliably, requires less maintenance and has a longer life.

Supply-voltage regulators and stabilisers have many fields of application. They are particularly useful in conjunction with electronic equipment, measuring equipment, photographic apparatus, X-ray and photocell equipment, pressductors, detectors, etc. They also constitute a useful form of auxiliary apparatus in installations containing components and auxiliary circuits which require a constant voltage as, for example, reference units i regulating circuits.

The requirements made on supply-voltage regulators an stabilisers can vary in individual cases, depending on th conditions under which they are to work. When designin such apparatus, it is thus necessary to make certai limitations so as to obtain equipment which will bot have a low price and will satisfy the requirements liabl to be made. The need to cover as large a power range a possible has led to the division of the apparatus int different types with a varying mode of operation.

For smaller outputs it is customary to use stabilisers an for larger outputs regulators.

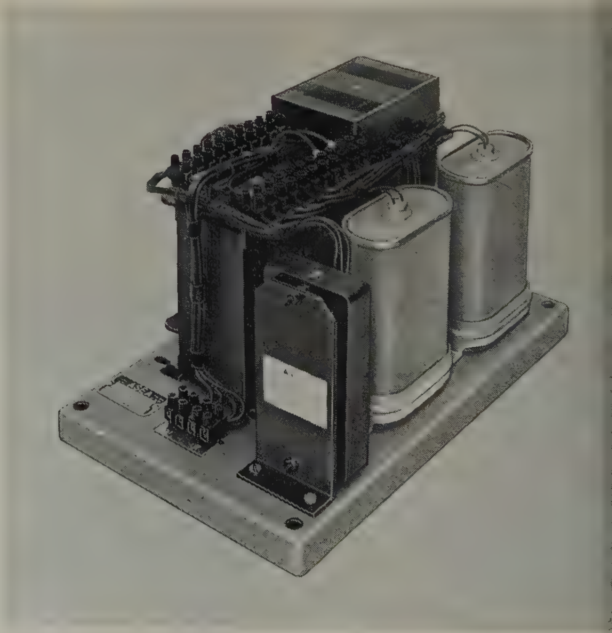
The regulators have a closed regulating loop, whic means that regulation is achieved by measuring the outpu voltage.

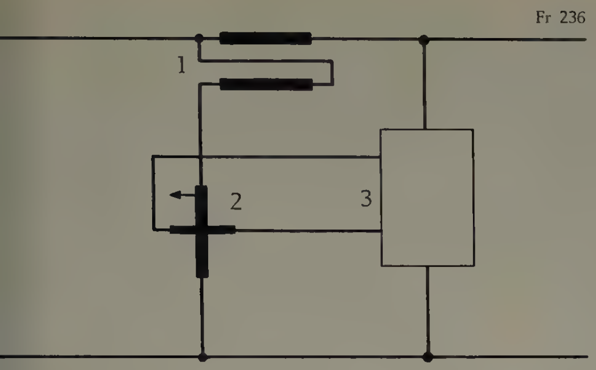


1 Saturated reactor
2 Non-saturated reactor
3 Filter reactor
4 Filter capacitor

Fig. 1. Elementary diagram of supply-voltage stabiliser type TUSB.

Fig. 2. Supply-voltage stabiliser type TUSB 500 with cove removed. Max. output 500 VA at P.F. – 0.8 – 1. The variations in the output voltage (220 V) are less than 1 per cen (55588)





Series transformer
Auto-self-excited transductor
Control-current device

. 3. Elementary diagram of supply-voltage regulator type NB.

ie stabilisers, on the other hand, are based on the inciple of a ferro-resonant circuit and a non-saturated actor. The ferro-resonant circuit incorporates a satu- ted reactor, whose characteristic curve determines the tput voltage level.

brief description is given in this article of the Asea biliser of type TUSB and regulators of types YTNB d YVNA. They cover together the output range of 0 VA to 44 kVA.

eir dimensions vary between 210 × 150 ×155 mm .3 × 5.9 × 6.1 in.) for the smallest stabilisers and 180 × 660 × 450 mm (46.5 × 26.0 × 17.7 in.) for e larger regulators, and their weights between approx. and 240 kg.

ABILISER TYPE TUSB

is stabiliser is available in four sizes, namely 100, 200, 0 and 1,000 VA. The main circuit of the stabiliser mprises a non-saturated and a saturated reactor, see g. 1. A capacitor is connected across the saturated actor so that a parallel resonance circuit is in principle rmed. These three components constitute together e voltage-stabilising portion of the regulator. In ad- ion, on the output side of the stabiliser there is a ter, comprising a reactor in series with the above- entioned capacitor.

r input voltage variations of +10 per cent to −15 per nt at 220 V, the output voltage will not vary by more an max. 4.4 V at constant load with a power factor of 3 to 1. The variations in the output voltage are not ways distributed, however, symmetrically around the minal value, but may lie more or less above or below s, but by not more than max. ±2 per cent. The rangement of the various components in the stabiliser n be seen from Fig. 2.

REGULATOR TYPE YTNB

This regulator is available for 1, 2, 4 and 6 kVA, and its elementary diagram is shown in Fig. 3.

The main circuit consists of a series transformer and an auto-self-excited transductor. The transductor is controlled by a sensing element, the object of which is to yield a control quantity proportional to the deviation of the regulated voltage from the nominal value. This can be achieved with the aid of a linear and a non-linear impedance. At normal voltage the currents through the impedances are of the same magnitude. If the voltage increases, the current through the non-linear impedance will then increase more than that through the linear one. The currents are compared after rectification in a bridge circuit, thus giving a differential current. This controls the transductor so that more voltage is taken up in the transductor circuit, which, in its turn, means that the output voltage will return to the nominal value. The output voltage is maintained constant with an accuracy of ±1.5 per cent for variations in the input voltage of +10 per cent to −15 per cent and load variations from no-load to full-load. In the case of an instantaneous alteration in the incoming voltage from −15 per cent to +10 per cent of the nominal value, the regulated voltage is restored to its nominal value within about 0.2 seconds for the smallest type and about 0.8 seconds for the largest type. The same time of adjustment also applies to a load variation from no-load to full-load.

The regulators for 1 and 2 kVA are accommodated in a box for mounting on a wall (Fig. 4), whereas the larger sizes for 4 and 6 kVA are incorporated in a cabinet which is intended to be placed on the floor.

The regulator is described in greater detail in the Asea Journal 31(1958):3, pp. 37–40 (also reprinted as Asea pamphlet 7593 E).

REGULATOR TYPE YVNA

This regulator can be used for higher outputs and for regulating larger variations in the supply voltage than the YTNB regulator, but, on the other hand, has a slightly lower rate of response, namely approx. 1 second. This regulator is available in several sizes between 2 and 44 kVA.

The regulator consists of a control device, a series transformer and a sliding-contact transformer with pilot motor. The smaller types have a reversing a.c. motor and the larger ones, a d.c. motor. The sliding-contact transformer supplies the series transformer with a voltage whose magnitude is dependent on the deviation in the supply voltage from the nominal value. The voltage induced in the series transformer is added to, or subtracted from, the input voltage so as to give a constant output voltage.

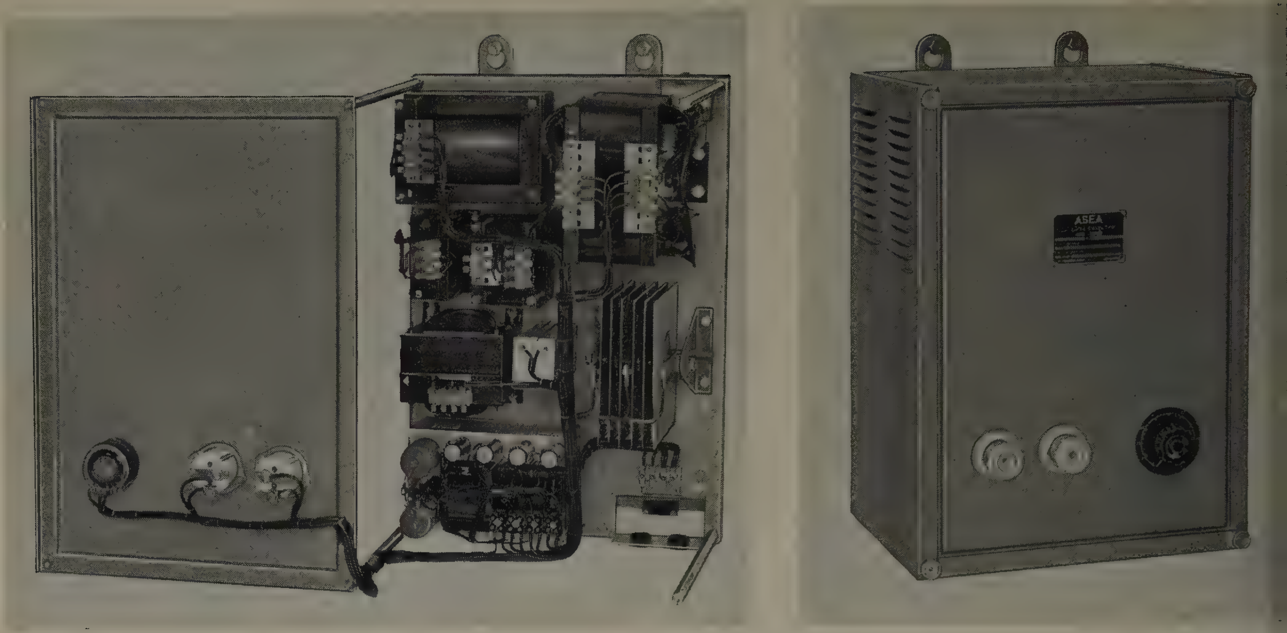


Fig. 4. Supply-voltage regulator type YTNB for 1 kVA in a box for mounting on a wall. Regulating accuracy ±1.5 per cent for variations in input voltage of +10 per cent to −15 per cent and load variations from no-load to full-load. Response time approx. 0.2 seconds. (49421, 49420)

The control device for this regulator type too has a linear and a non-linear impedance. The differential current from these causes the output of one of the transductors in the regulator to increase and the other to decrease. In this way, current is fed to one or other of the windings of the a.c. motor. With the d.c. motor, whose field circuit is fed with a constant voltage, the polarity of the rotor, and consequently the direction of rotation of the motor shaft, is determined by which of the transductors increases its output. The motor actuates via gearing the sliding contact of the transformer.

The components in the smaller sizes of regulator are accommodated in a sheet-steel box for mounting on a wall and, for the larger types in a cabinet which is intended to be placed on the floor.

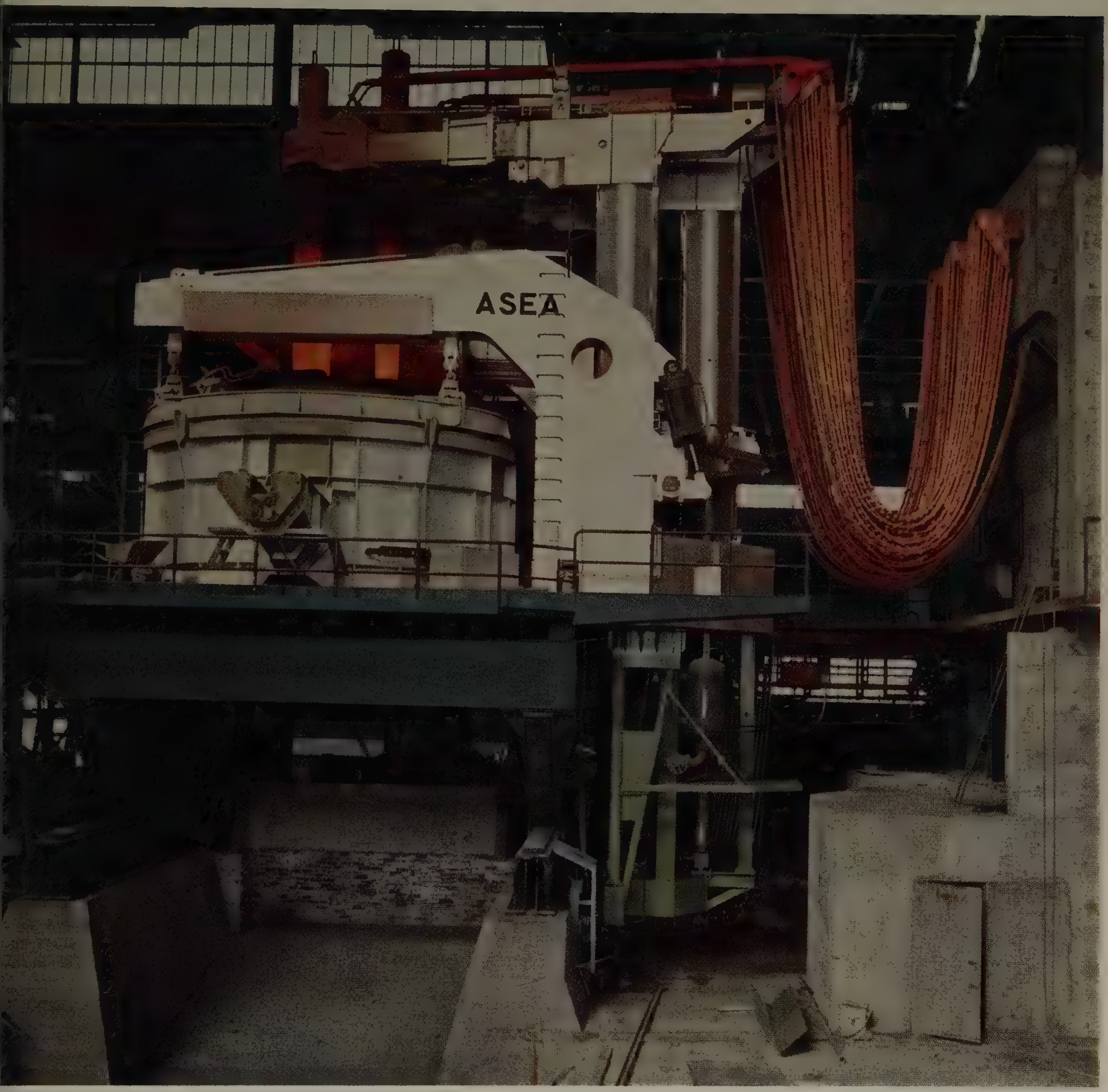
The regulator is described in greater detail in the Ase Information sheet 4809 0424 E.

PARALLEL SERVICE, THREE-PHASE SERVICE, HARMONICS

Two or more regulators or stabilisers may work i parallel, provided the installation is supplemented by a interphase transformer, which divides the load betwee the different regulators.

Three-phase service is also possible if three regulator or stabilisers are star-connected and the neutral of th network brought out. The equipment will then regulat on a constant voltage to neutral, and consequently th voltage between lines will be maintained constant onl for a balanced load. Three-phase service with delta cor nection is not possible because of circulating currents i the main circuits.

The harmonic content for the above-mentioned stabilise and regulators is insignificant and is of no practic importance in the majority of cases.



(F 967)

EWS IN BRIEF

RGE ARC FURNACE SUPPLIED
CUSTOMER IN NORWAY

Asea Furnace Department has re-
tly supplied its largest arc furnace
allation hitherto to A/S Norsk Jern-
, Mo i Rana. The arc furnace has
hell diameter of 5.8 m (19 ft) and
ansformer output of 22 MVA. About
tons of steel can be melted in the
nace at a time.

illustration shows the furnace instal-
on from the tapping side. On the right
the copper conductors leading the current to the three graphite electrodes each of which has a maximum current rating of 38.1 kA.

The furnace power is regulated by means of an Asea electro-hydraulic high-speed regulator which is also well known in other spheres such as turbine governing, gun-laying and the steering of submarines when submerged.

On 15th June, 1961, the plant at Mo i Rana was visited by representatives of the management of Asea under the leadership of Dr Åke T. Vrethem. Mr M. Böckman, the Managing Director of the Asea subsidiary company in Oslo, A/S Per Kure, where the furnace transformer was manufactured, also took part.

Norsk Jernverk was represented by, amongst others, the Director General, Mr D. Efjestad, and the Works Director, Mr G. Langberg.

Speeches were made by both parties expressing satisfaction over the excellent spirit of Scandinavian co-operation in which this plant was created.

Asea Reg. 663

EXTRA POWERFUL TRACTION MOTORS AND SEVERAL ORE LOCOMOTIVES ORDERED

Asea is probably still the largest manufacturer in the world of traction motors for single-phase alternating current. Further, one of the motor types, KJ 136, with its variants (Fig. 1), is notable in that its output, during the 35 years the type has been manufactured, has been successively increased by no less than 81 per cent. The motor still has the same external dimensions and the same insulation (Class B) as it originally had. Naturally, an even greater increase in output would have been achieved if in addition, an insulation with a higher permitted temperature rise, for example, Class F or H, had been adopted.

In addition to the increase in output, Table 1 also shows the number of machines and their combined output, and, as far as records are concerned, the figures quoted in the table can hardly be exceeded by any other manufacturer.

It has also been possible to force down the maintenance costs. Improvements in design have made it possible to increase the interval between commutator overhaul and, at the same time, brush wear has been reduced. In the first locomotives with motors of type KJ 136, the overhaul period is 200,000 km, while many motors of the type most recently supplied (KJC 137) have already passed the 1,000,000 km mark without there being any need to overhaul the commutators. As far as brush wear is concerned no definite figures are available for the first motor type (KJ 136). For the second type (KJ 137) it is about 0.29 mm per 1,000 locomotive-kilometres and for the type most recently supplied (KJC 137) about 0.13 mm per 1,000 locomotive-kilometres.

Since the motor is interchangeable, it is now possible to put new motors in old locomotives and thus obtain locomotives which have a considerably higher performance than when they were first supplied perhaps 35 years ago. In the case of KJC 137 motors, which have a increased output of 51 per cent over the original motor, it has proved that the electrical equipment in the older locomotives as well as their mechanical parts were so generously designed that these more powerful motors can be put in without having to make any other changes or modifications in the locomotive.

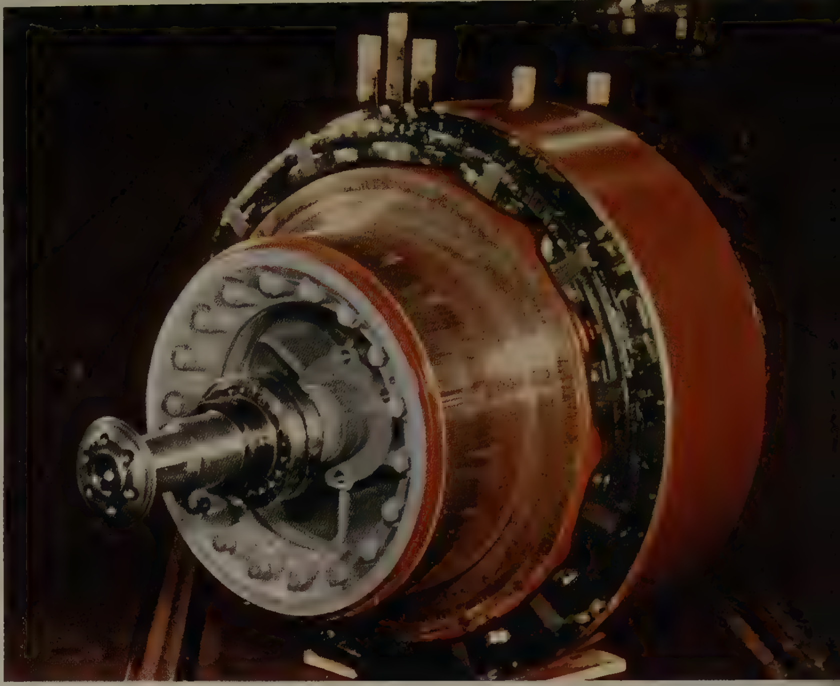


Fig. 1. The Asea single-phase a.c. traction motor, type KJ 136–137, is notable in th its output has successively been increased by 81 per cent during the 35 years t type has been in production. The motor has the same external dimensions and t same insulation (Class B) as it originally had. The illustration shows type KJC 1 ready to be installed in a locomotive, the motor frame of which is designed to car the rotor bearing and to support the stator ring and brush rocker. (F 898)

This brief information on the development of a special machine can be supplemented by some remarks on the locomotives in which this type of motor is used.

The motor type originally designed for the well-known Swedish D-locomotive was, to begin with, made wi differing gear ratios for use either passenger locomotives or in goods comotives. When motor type KJ 137 w adopted, the locomotive was redesign ed Dk and could then be used as mixed-traffic locomotive. Its most rece successors, the Da and Dm locomotiv

Table 1. The development up to and including November, 1961 of the single-pha traction motor type KJ 136–137. The motor has been manufactured throughout wi the same external dimensions and the same insulation (Class B). The combin single-phase output (1-hour rating) hitherto for this type of traction motor is 1. million horse-power.

Data	KJ 136	KJ 137	KJC 137	KJD 137
Data for 1-hour rating:				
Output, kW	610	736	920	1,100
Output, h.p.	830	1,000	1,250	1,500
Voltage, V	390	377	395	422
Current, A	1,820	2,200	2,660	3,040
Speed, r/m	730–1,100	760–1,100	770–1,100	770–1,100
Output, %	100	121	151	181
Other data:				
First order received	1924	1934	1949	1960
Number of motors ordered or delivered	554	223	709	180
Total rating, h.p.	459,820	223,000	886,250	270,000

the type variant KJC 137. The latest iant KJD 137 is primarily intended the Dm and Dm 3 locomotives, and motors which they replaced are now be used in other types of locomotive. anging the motor has, for example, reased the one-hour rating for the Dm 3 locomotive from 7,500 to 9,000 h.p., and it should be possible to increase the present tractive effort of the locomotive of 80 tons to 95 tons. In other words, the record-breaking locomotive of last year will soon be about 20 per cent more powerful. A large series of the new double locomotive (Dm) with the more powerful motors has also recently been ordered (November, 1961) and a further increase in the series is being discussed as well as further intermediate sections for the Dm 3 locomotives. Asea Reg. 4401, 6132

MOTE-CONTROL EQUIPMENT R DEMONSTRATION AND STING

e equipment comprises apparatus for note indication in accordance with the ea impulse-code system (Pamphlet 4 Ea) and for remote indication in ordance with the Asea period-time tem (Description Fag 1133 E).

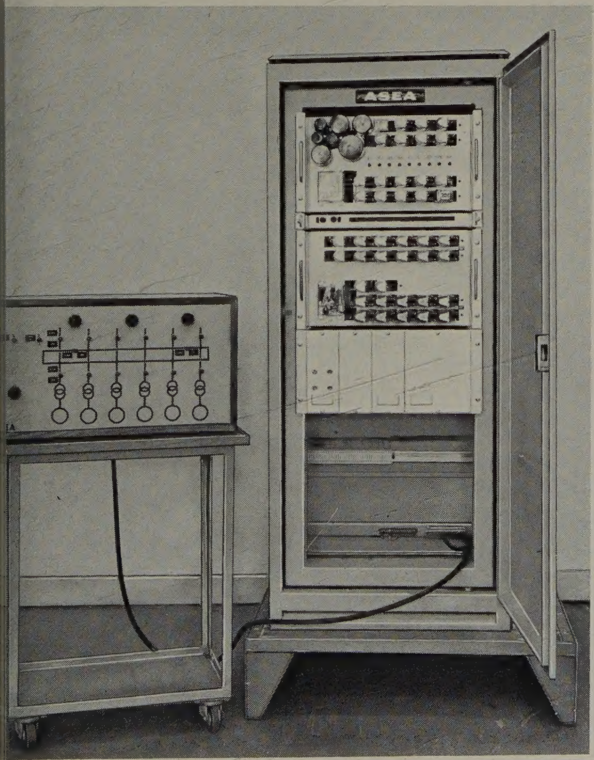
e control panel in the left-hand illution represents a switchyard, from ich circuit-breaker positions and meang values can be obtained. The cabinet tains the necessary control equipment the code transmission of position ications and measuring values.

The control panel in the right-hand illustration is a part of a normal control panel for remote-control purposes and shows actual circuit-breaker positions and measuring values. The cabinet contains the necessary control equipment for the code reception of position indications and measuring values.

In all, the equipment can transmit 20 three-position indications and 15 measuring values, the latter cyclically. For reasons of space, the reception cabinet has been equipped for only four measuring values.

The entire equipment can be situated either in one room, for example for demonstration purposes, or separately, whereupon the equipment in the left-hand illustration is placed in, for example, a power-station and the equipment in the right-hand illustration in a control room situated at a greater or lesser distance from the power-station. In either case, the medium of transmission can be either cable, carrier frequency on the power line or radio link.

If the transmission equipment is placed in a power-station, the circuit-breaker positions and measuring values can be obtained either from the small control panel or from the actual objects in the power-station. Asea Reg. 507



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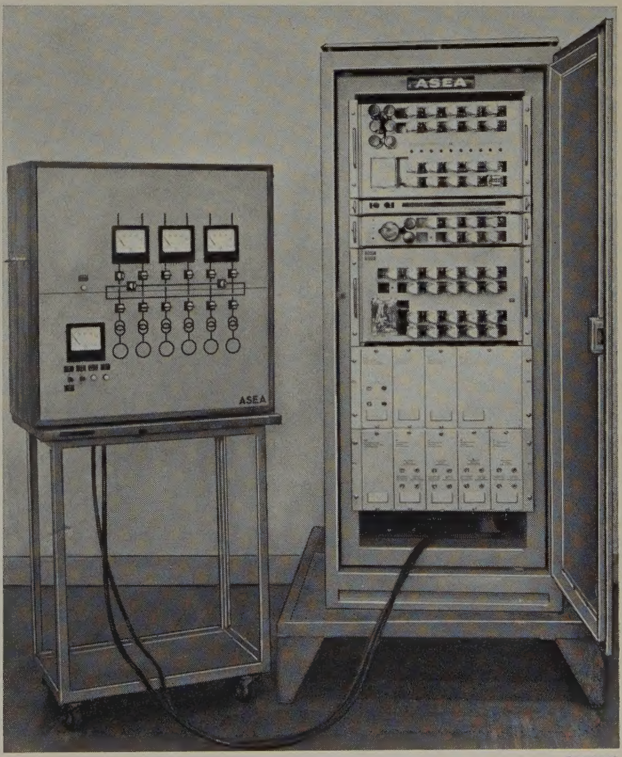

(56308)

The condenser was set up, with help from Asea, by the customer's staff who can be seen here just before the rotor and stator were assembled. The illustration shows the one end of the rotor itself resting on a support and the rotor shaft fastened to a trestle so that the stator can be pushed over the rotor. (F 935)

SYNCHRONOUS CONDENSER FOR CHILE

Asea have supplied a synchronous condenser and a static capacitor battery to a substation in Chile. The station is situated in the town of Concepción, about 600 km (375 miles) south of Santiago, and forms the terminal point of two 154 kV lines from the Abanico power-station in the Andes, and is also the point from which distribution at various voltages to the industrial area around Concepción takes place. The plant is the property of the government-owned company Empresa Nacional de Electricidad S.A. (Endesa).

The synchronous condenser is rated at 20 MVA at 1,000 r/m, 50 c/s, 13.8 kV and is provided with a main exciter, auxiliary exciter and starting motor on a common shaft. The set is clad in sheet steel and is of outdoor design. It has been built to withstand a climate with hot sandstorms in the summer and cold rainstorms in the winter.

The starting equipment is interesting in so far as the set is run up by means of a slip-ring induction motor, the synchronous speed of which is 1,500 r/m, that is to say one step above that of the synchronous condenser. The motor is connected to the 380 V local network. Phasing takes place when the set is slowly running down, while the motor remains on the 380 V network and has a high resistance connected into its rotor circuit.

The static capacitor battery comprises 8 groups with 90 single-phase elements of type CTD 2 in each group, and has a total reactive output of 20 MVAr at 13.8 kV, 50 c/s.

The Asea delivery further included three sets of metal-clad outdoor switchgear containing the circuit-breakers and other equipment for the capacitor battery, as well as the starting and high-speed regulating equipment for the synchronous condenser.

The substation also has a previously installed synchronous condenser of another make with the same output as the Asea one (20 MVA), but having a speed of 750 r/m. The condenser equipment is intended to keep the voltage on the 154 kV busbars in Concepción constant. This is done automatically by switching the groups in the static capacitor battery on and off and, between steps, by means of fine regulation of the reactive output by means of the Asea synchronous condenser. The other synchronous condenser is not provided with high-speed regulation and is therefore to be run with fixed excitation. The automatic control circuit has been planned and built by Endesa using, to some extent, special Asea relays.

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ASEA JOURNAL
1961 VOLUME 34

CONTENTS

30-ton induction furnaces for melting and holding iron 2
by S. Carlsson

The manufacture of control rods in the Asea Nuclear Power Department 2
by B. Mills

Overhead cranes for an iron store 2
by A. Sahlberg

An ampere-hour meter for submarines 2
by L. Faxö

Supply-voltage stabilisers and regulators 2
by B. Nylund

News in brief 2

Large arc furnace supplied to customer in Norway

Extra powerful traction motors and several ore locomotives ordered

Remote-control equipment for demonstration and testing

Synchronous condenser for Chile

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